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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

TANK INVESTIGATION OF THE HYDRODYNAMIC CHARACTERISTICS OF A 1/13.33-SCALE JET-POWERED DYNAMIC MODEL OF THE MARTIN XP6M-1 FLYING BOAT WITH A REVISED FOREBODY PLANING BOTTOM

TED NO. NACA DE 385

By Ulysse J. Blanchard and Arthur W. Carter

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Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

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SUMMARY

Hydrodynamic characteristics have been determined for a 1/13.33-scale jet-powered dynamic model of the Martin XP6M-1 flying boat with the forebody modified so as to increase the depth of step and the angle between the forebody and afterbody keels. Longitudinal stability during take-off and landing in smooth water and resistance of the complete model in smooth water and in waves are presented.

INTRODUCTION

A brief tank investigation of the hydrodynamic characteristics of a preliminary design of the Martin XP6M-1 flying boat was described in reference 1. A tank investigation of the hydrodynamic characteristics of a revised model which was representative of the final design of the XP6M-1 was described in reference 2. At speeds near take-off, the trim limits of the basic model described in reference 2 were indeterminable because divergent porpoising was encountered. In addition, the smooth-water resistance of the basic model appeared to be high near take-off. The resistance in waves also was high.

In an effort to improve these characteristics, a tank investigation has been made with a revised version of the basic model. This revision consisted essentially of a change in the relative angle between the forebody and afterbody keels from 6° to 7° and an increase in the depth of the step. This revision was accomplished by adding a wedge to the forebody planing bottom. The results of tests described in references 1 and 2 indicated that the increased afterbody clearance would be desirable.

The hydrodynamic characteristics investigated include longitudinal stability during take-off and landing, and resistance of the complete model in smooth and rough water.

DESCRIPTION OF MODEL

The 1/13.33-scale jet-powered dynamic model, Langley tank model 316B-1, is shown in figure 1. The model was essentially the basic Martin design (Langley tank model 316) as described in reference 2 but with a revised forebody planing bottom such that the relative angle between the forebody and afterbody keels was increased to 7°. As shown in figure 2, the basic hull was modified by adding a 1° wedge-shaped block to the forebody bottom. The depth of a cross section through the wedge at station 648 was a constant value of 7.07 inches (full size) from chine to chine, thus retaining the original contour of the forebody planing bottom. Straight buttock lines were faired through this station, tangent to the bow, and extended aft to the existing step. The total depth of step at the keel was 11.37 inches (0.103 beam).

The bow spray strip of Langley tank model 316-5 (ref. 2) was retained, as well as the same wing, nacelle, tip float, and tail configurations.

Jet power was simulated by compressed-air nozzles mounted in the nacelles as described in references 1 and 2. The pitching moment of inertia of the ballasted model was 6.2 slug-ft^2.

APPARATUS AND PROCEDURE

The apparatus was the same as that used during previous investigations of models of the XP6M-1 (refs. 1 and 2). The setup of the model of the XP6M-1 on the towing apparatus is shown in figure 3.

Unless otherwise noted, the hydrodynamic characteristics were determined at a gross load which corresponded to 160,000 pounds, with a flap deflection of 40°, and with the center of gravity located at 28.5 percent mean aerodynamic chord.

Trim limits of stability, accelerated take-offs, smooth-water landings, and total resistance of the complete model were determined by the same methods as those used for the tests described in reference 2.

All trim measurements for model 316B-1 are referred to the keel of the basic model (Langley tank model 316).

RESULTS AND DISCUSSION

All test results have been converted to values corresponding to the full-size flying boat.

Trim limits of stability.- The trim limits of stability are presented in figure 4. In general, there was a wide range of stable trims between the upper and lower trim limits and recovery from both lower- and upper-limit porpoising was possible at all speeds. The upper limit, decreasing trim, was not determined because of apparent sticking of the afterbody which required a large bow-down aerodynamic moment to recover from upper-limit porpoising. When a sufficient moment was applied, the model would recover but, because of the sudden change in trim, the values for the upper limit, decreasing trim, could not be obtained accurately. The model showed no evidence of the divergent porpoising encountered with the basic model (ref. 2) at high speeds.

Accelerated take-offs.- The variation of trim with speed during take-off in smooth water is shown in figure 5. The lower trim limit and the take-off speed also are shown. The hump trim was not materially affected by changes in the aerodynamic moment. Several of the trim tracks intersected the lower trim limit, causing mild trim oscillations. These oscillations in trim did not exceed $1\frac{1}{2}^{\circ}$ in amplitude. The intermediate porpoising obtained with the basic model (ref. 2) at high speeds was not obtained with the revised forebody. No upper-limit porpoising was encountered throughout the range of stabilizer positions and all take-offs were stable through the high-speed range. The take-off stability appeared to be excellent.

Landing stability.- Typical time histories of trim, rise, and speed during landings in smooth water are presented in figure 6. The maximum variation of trim and rise and the number of skips (hull left the water) are presented in figure 7 for various landing trims. These data are similar to the data obtained with the basic model and in general the landing stability in smooth water was excellent.

Resistance.- The total resistance and trim in smooth water are presented in figure 8. The solid lines represent the minimum total resistance and the trim for minimum resistance.

In general, the resistance over the hump and at intermediate planing speeds was similar to that obtained with the basic model. At high speeds, no tendency toward a second hump such as was found for the basic model was observed. On the other hand, the total resistance at high speeds was practically a constant value.

The effect of wave height on the average total resistance was determined with flap deflections of 10° and 40° in waves 2, 4, and 6 feet high and 200 feet long. These data are presented in figure 9. The resistance in 2-foot waves was approximately the same as that in smooth water at low speeds but increased at higher speeds. The resistance increased rapidly with increase in wave heights greater than 2 feet. A comparison of the resistance with the two flap deflections indicated that 40° flaps were not advantageous until speeds near take-off were obtained. Apparently the spray striking the flaps increased the resistance more than the more rapid unloading decreased the resistance of the hull.

In general, the rough-water resistance was less than that obtained with the basic model (ref. 2).

CONCLUDING REMARKS

Tank tests of a 1/13.33-scale dynamic model of the Martin XP6M-1 flying boat with a revised forebody planing bottom indicate that the longitudinal stability during take-off and landing was excellent. The model showed no evidence of the divergent porpoising encountered with the basic model at high speeds. The smooth-water resistance at high speeds and generally the rough-water resistance were less than those obtained with the basic model.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., October 3, 1955.

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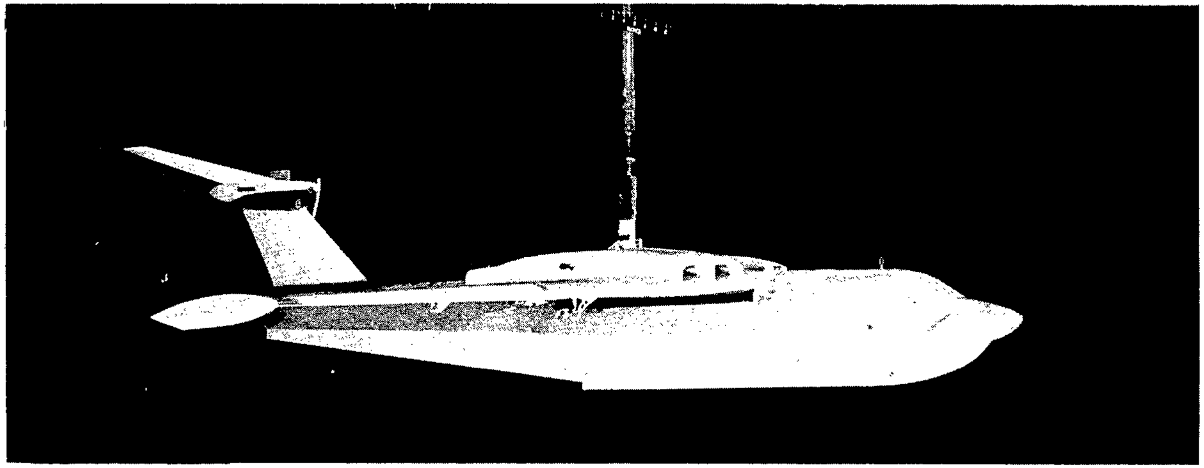
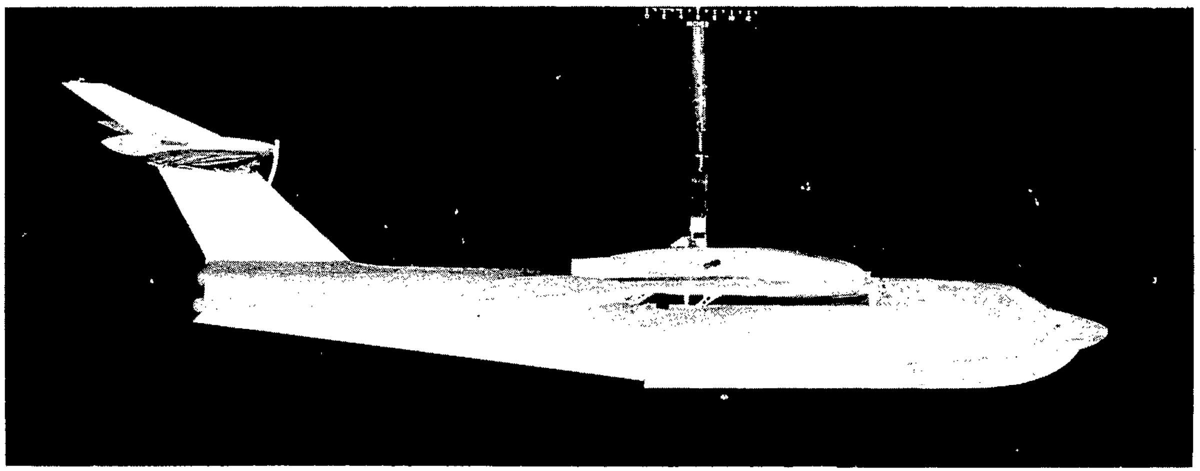
1. Blanchard, Ulysse J.: A Brief Investigation of the Hydrodynamic Characteristics of a 1/13.33-Scale Powered Dynamic Model of a Preliminary Design of the Martin XP6M-1 Flying Boat - TED No. NACA DE 385. NACA RM SL53K06, Bur. Aero., 1953.

2. Carter, Arthur W., and Blanchard, Ulysse J.: Tank Investigation of the Hydrodynamic Characteristics of a 1/13.33-Scale Jet-Powered Dynamic Model of the Martin XP6M-1 Flying Boat - TED No. NACA DE 385. NACA RM SL55D06, Bur. Aero., 1955.



Three-quarter front view



Profile view

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Figure 1.- Langley tank model 316B-1.

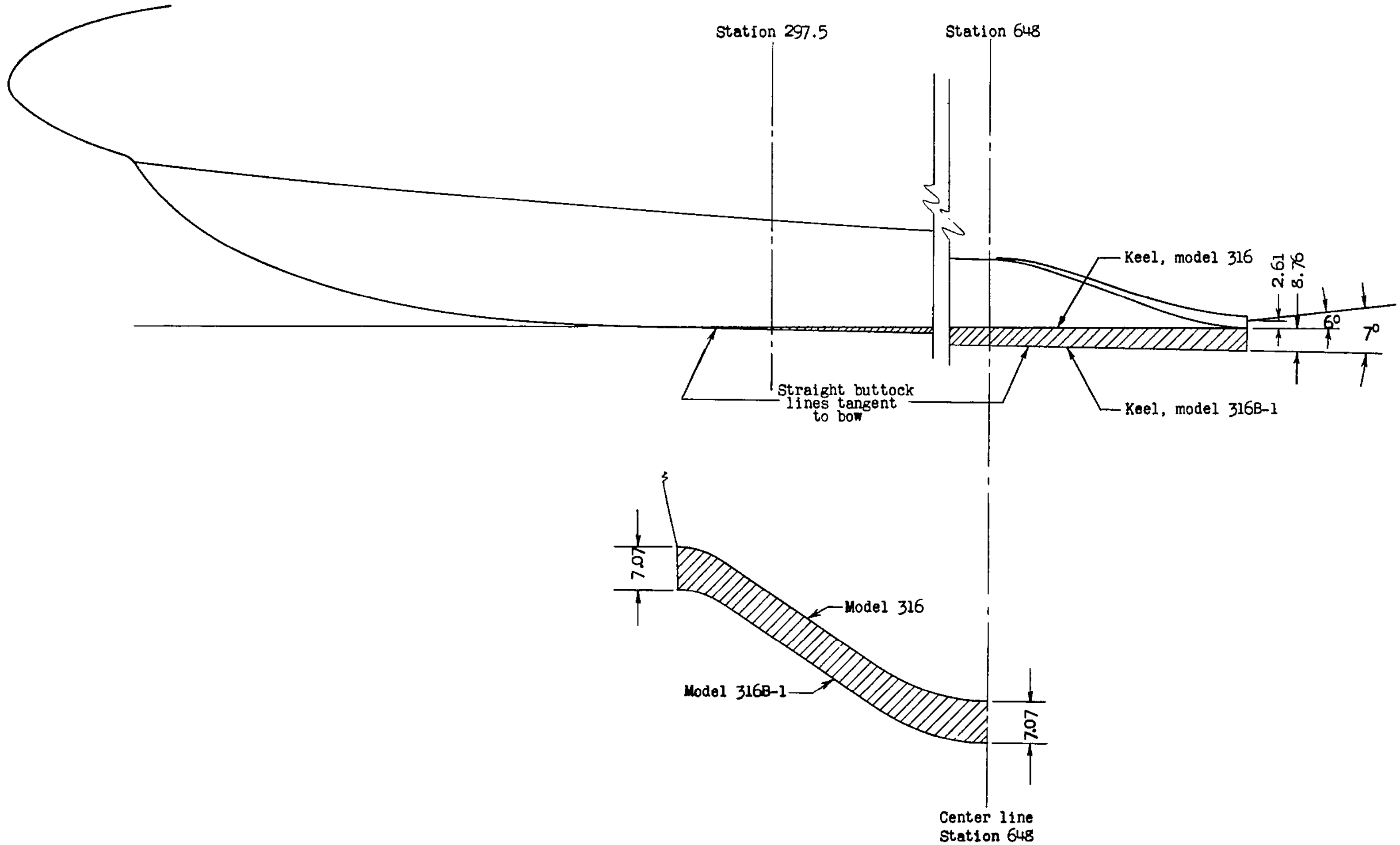

Figure 2.- Modification of Langley tank model 316 forebody to Langley tank model 316B-1 configuration. Dimensions are in inches, full size.

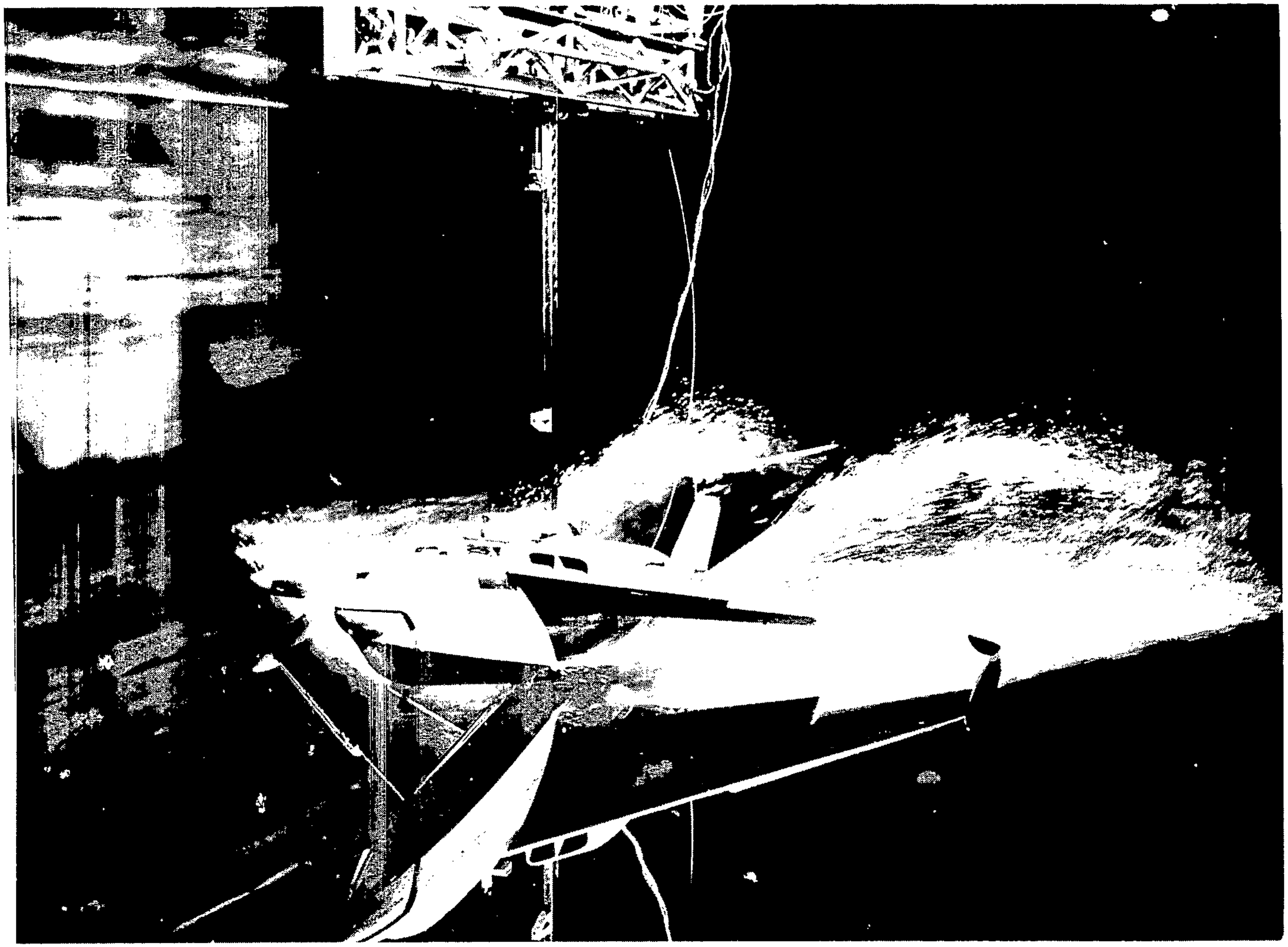

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Figure 3.- Setup of Langley tank model 316B-1 on towing apparatus.

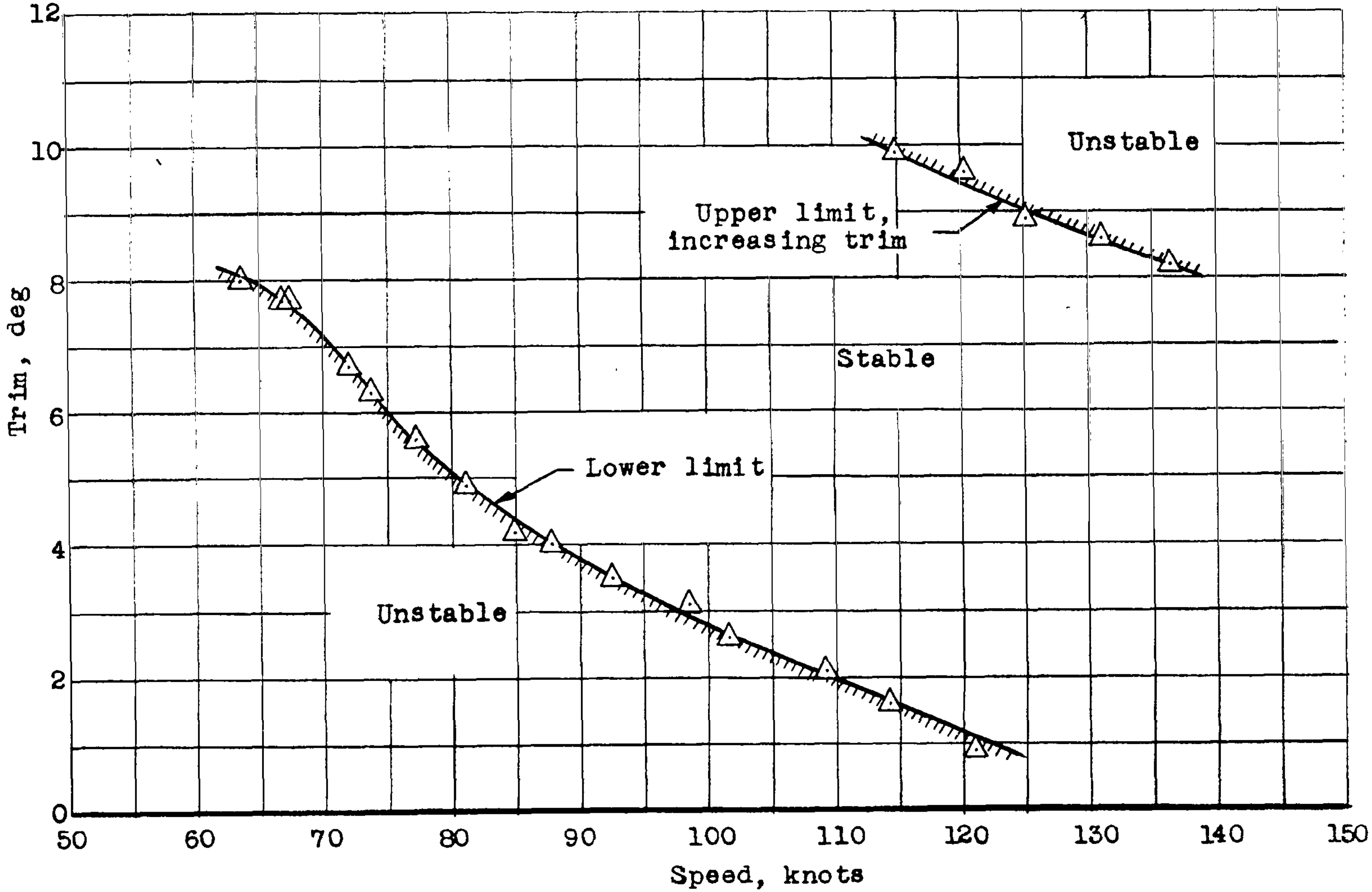


Figure 4.- Trim limits of stability. Gross load, 160,000 pounds; flaps, 40°; power off. Langley tank model 316B-1.

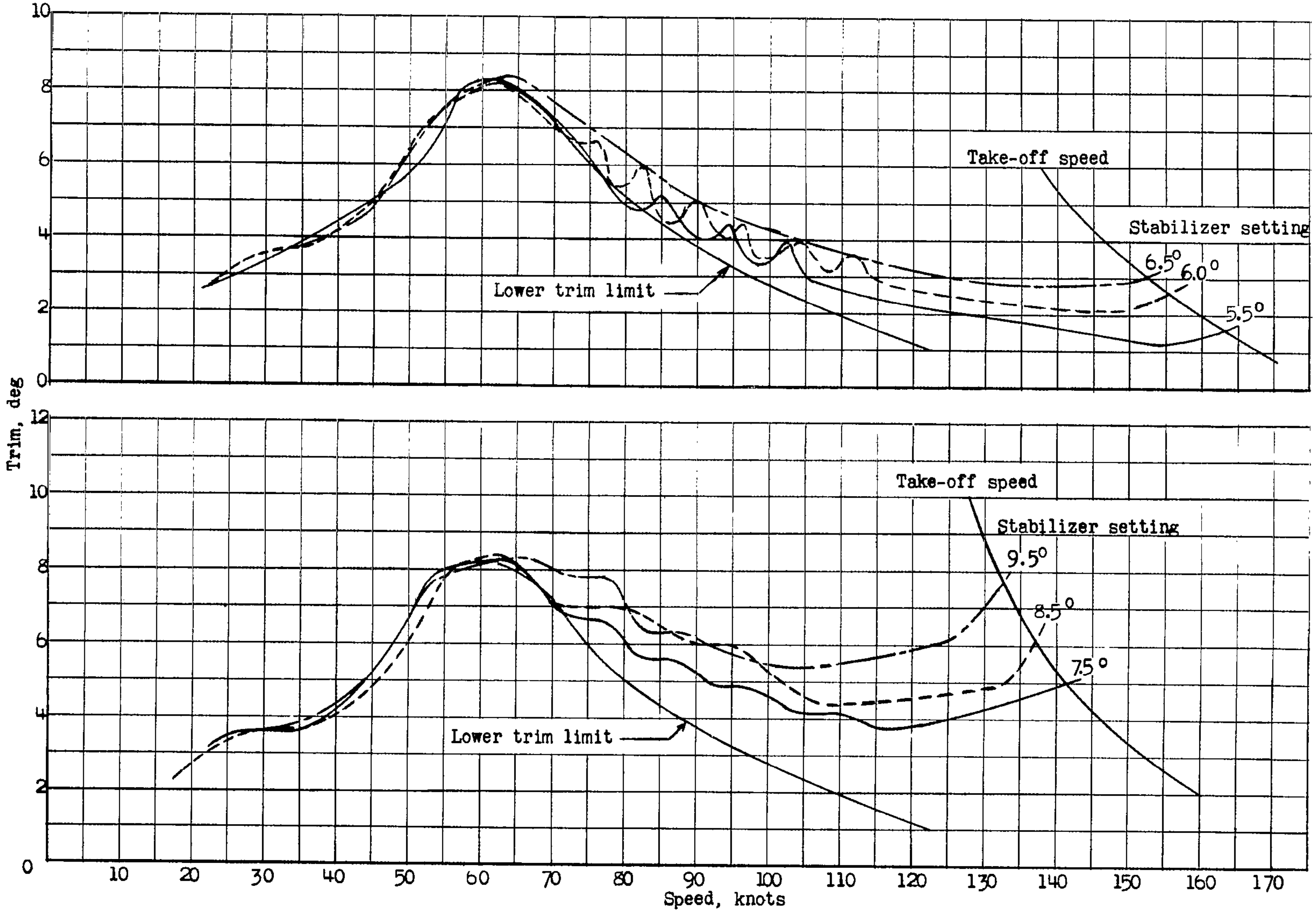


Figure 5.- Variation of trim with speed during take-off. Gross load, 160,000 pounds; flaps, 40°; power on. Langley tank model 316B-1.

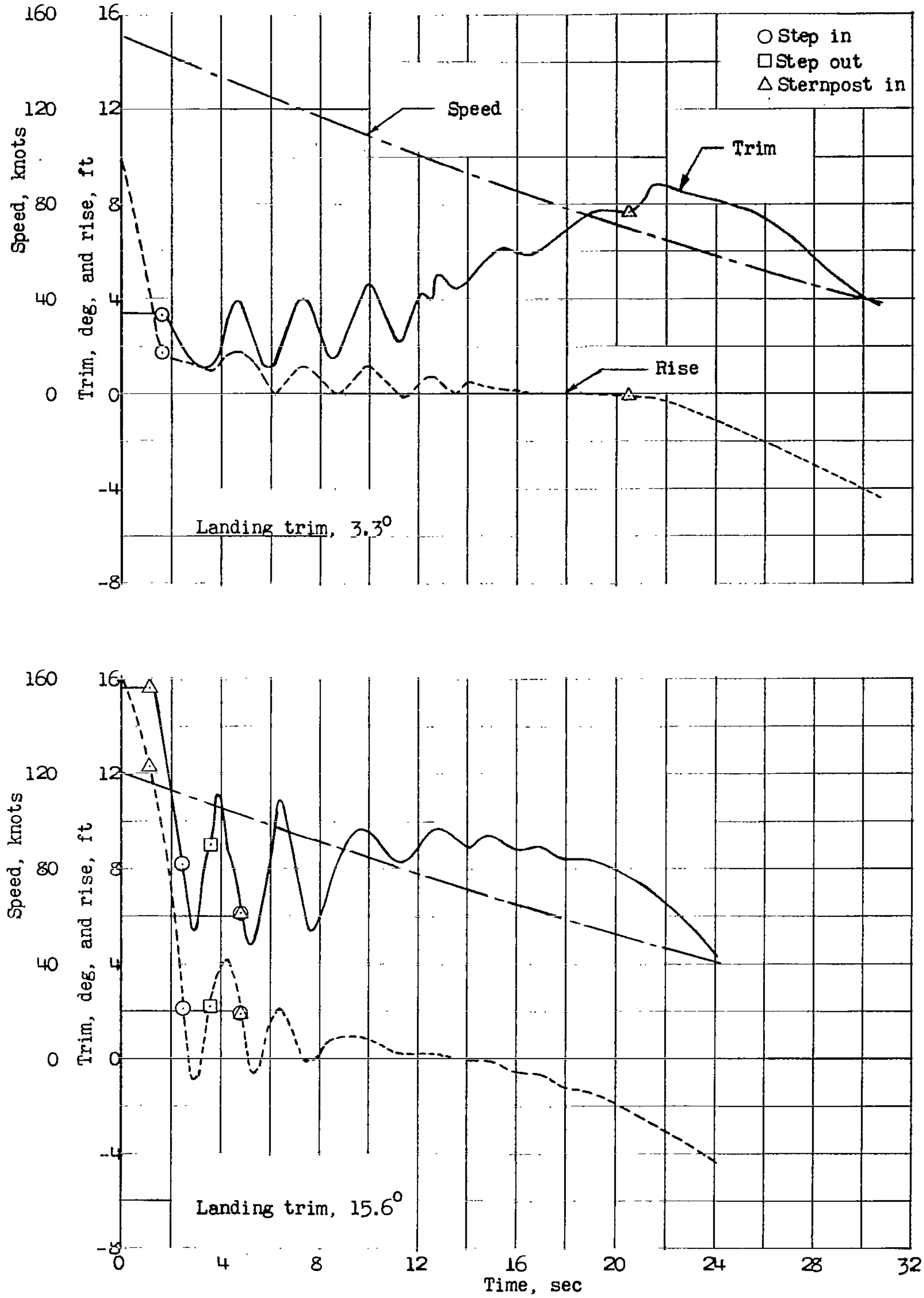


Figure 6.- Variation of trim, rise, and speed with time during typical landings in smooth water. Gross load, 160,000 pounds; flaps, 40°; power off. Langley tank model 316B-1.

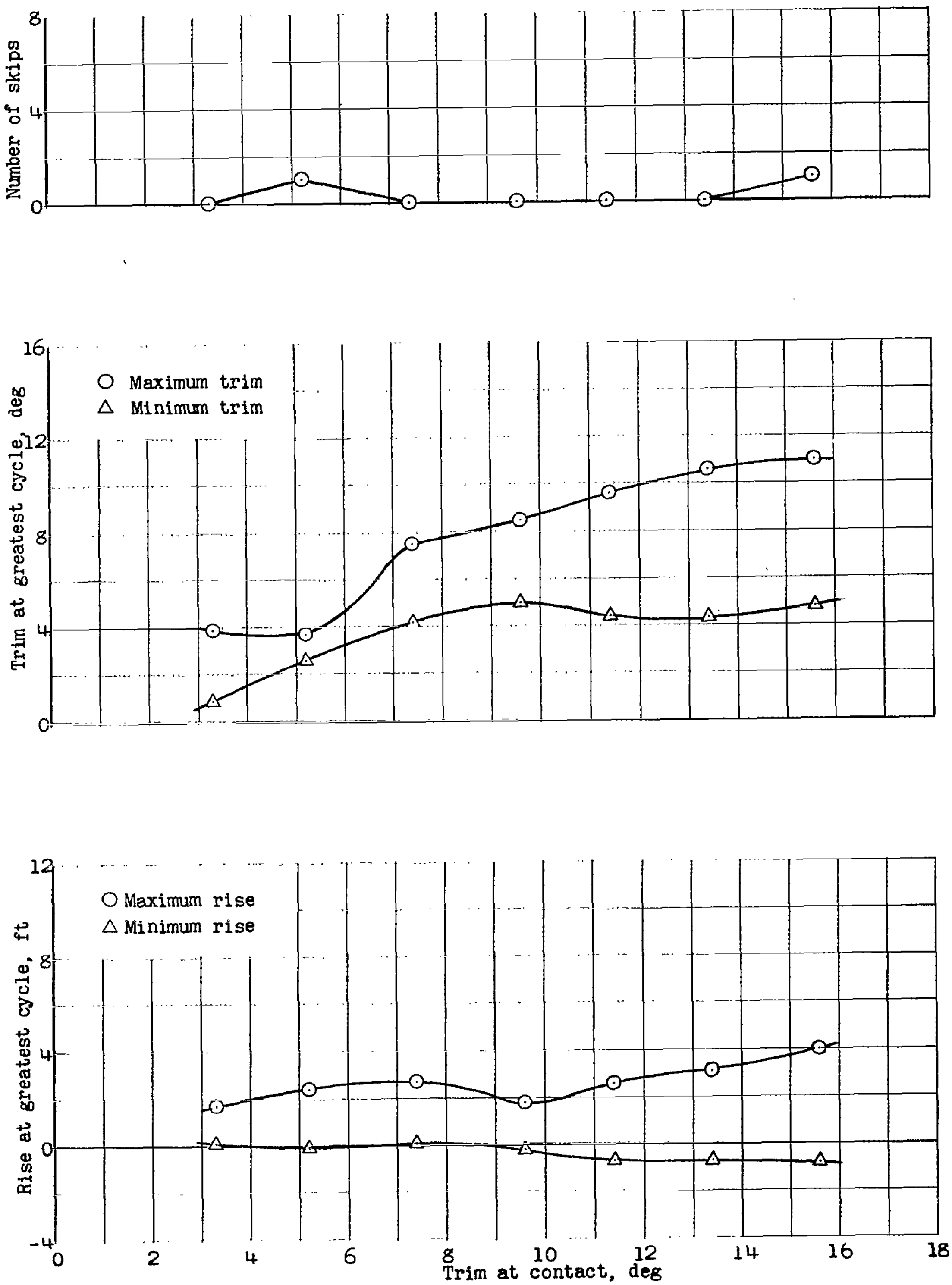


Figure 7.- Landing stability characteristics in smooth water. Gross load, 160,000 pounds; flaps, 40°; power off. Langley tank model 316B-1.

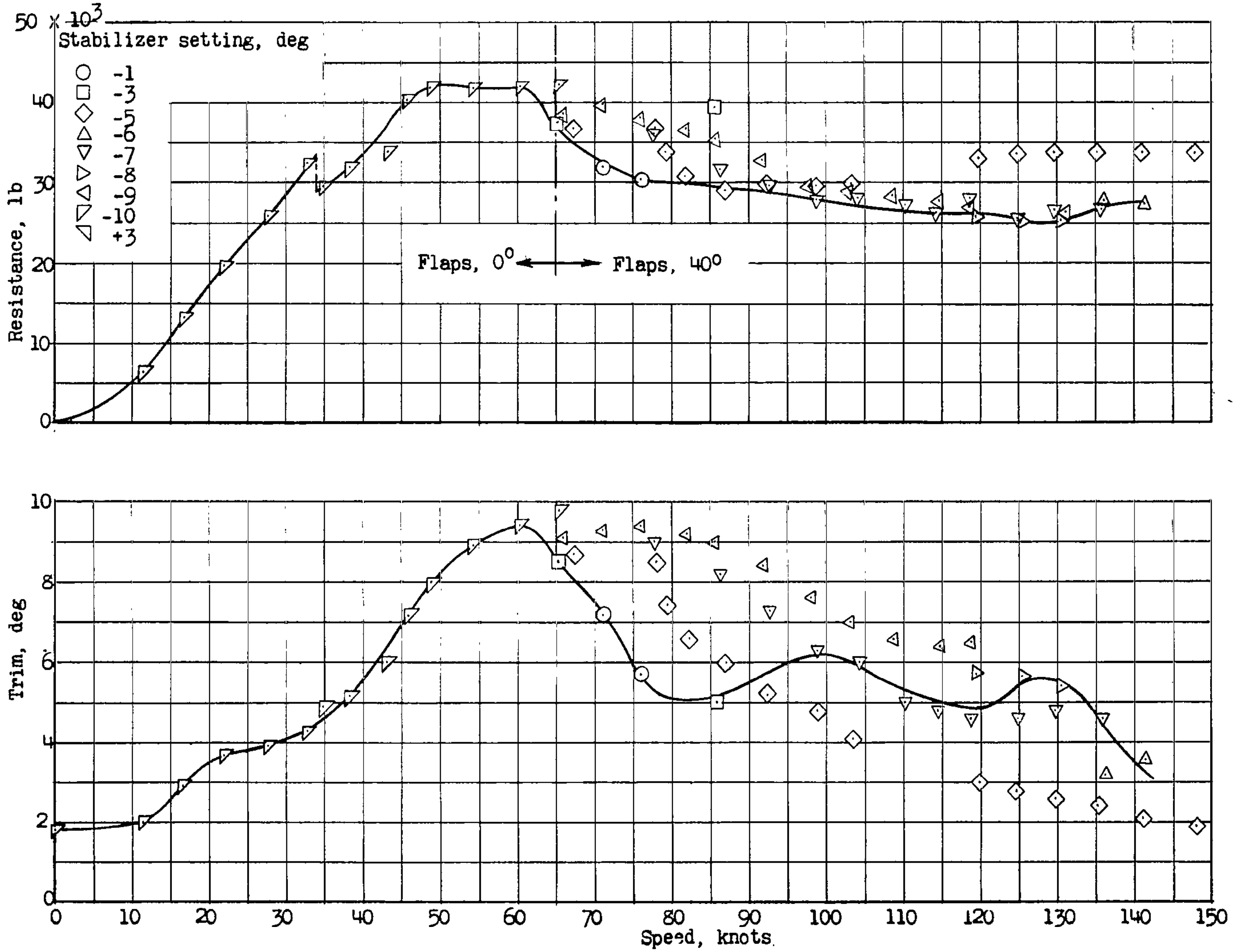
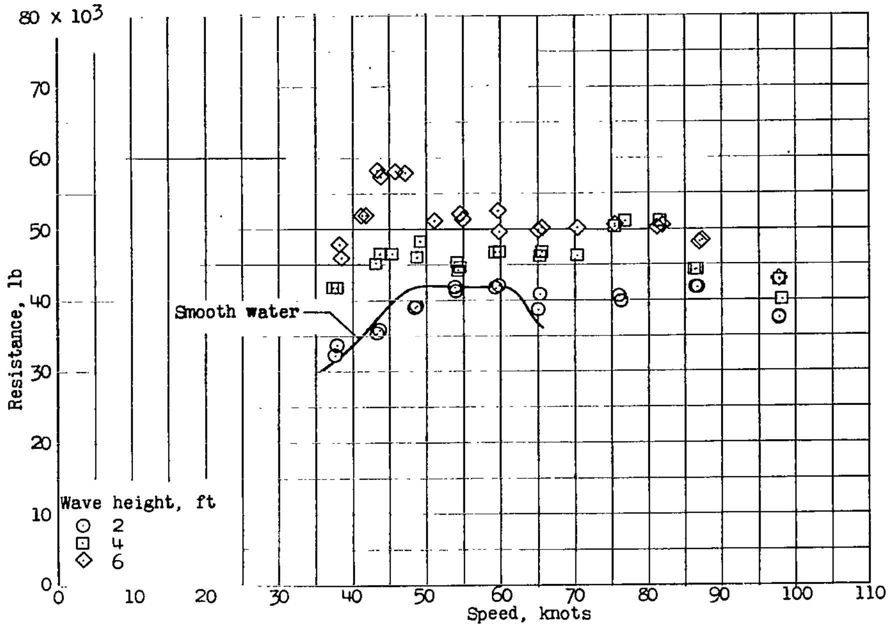
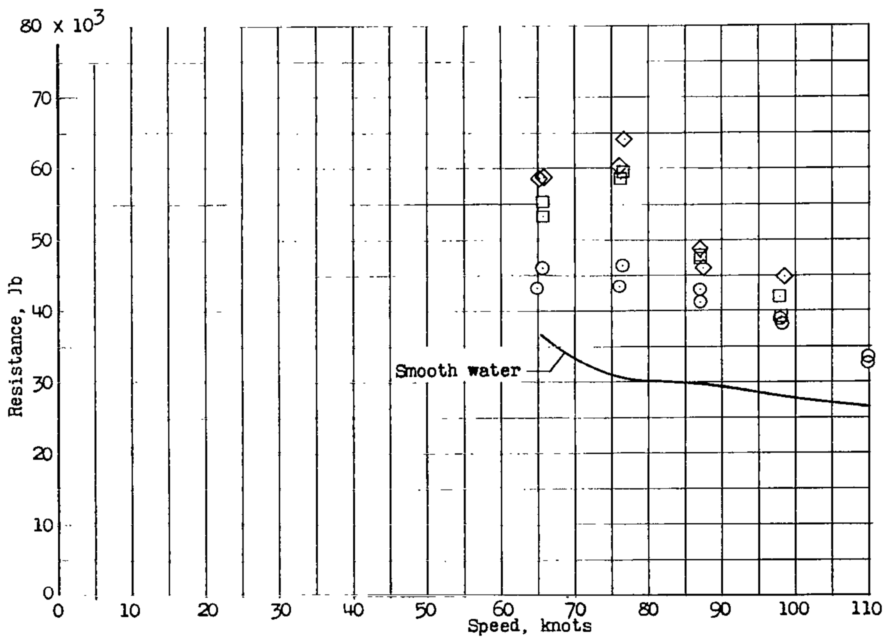


Figure 8.- Minimum total resistance and best trim. Gross load, 160,000 pounds; power off. Langley tank model 316B-1.



(a) Flap deflection, 10°.



(b) Flap deflection, 40°.

Figure 9.- Effect of wave height on average total resistance in rough water. Gross load, 160,000 pounds; power off; wave length, 200 feet. Langley tank model 316B-1.